More recently, OSHA developed policies that require the recording of positive tuberculin skin-test results.[29] It would be beneficial to health care organizations and personnel if the principles of record keeping and confidentiality mandated by OSHA were to be expanded to other work-related exposures and incidents, immunizations, TB screening, and investigation and management of nosocomial outbreaks.

E. EPIDEMIOLOGY AND CONTROL OF SELECTED INFECTIONS TRANSMITTED AMONG HEALTH CARE PERSONNEL AND PATIENTS

Almost any transmissible infection may occur in the community at large or within health care organizations and can affect both personnel and patients. Only those infectious diseases that occur frequently in the health care setting or are most important to personnel are discussed here.

1. Bloodborne pathogens

a. Overview

Assessment of the risk and prevention of transmission of bloodborne pathogens, such as hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV), in health care settings are based on information from a variety of sources, including surveillance and investigation of suspected cases of transmission to health care personnel and patients, seroprevalence surveys of health care personnel and patients, and studies of the risk of seroconversion after exposure to blood or other body fluids from infected persons. In this document, the emphasis of the discussion of bloodborne pathogens will be on patient-to-personnel transmission.

The CDC has periodically issued and updated recommendations for prevention of transmission of bloodborne pathogens in health care settings; these provide detailed information and guidance.[30-40] Also, in 1991 OSHA published a bloodborne pathogen standard that was based on the concept of universal precautions to prevent occupational exposure to bloodborne pathogens.[27] The use of standard precautions (which incorporates universal precautions), including appropriate handwashing and barrier precautions, will reduce contact with blood and body fluids.[3,30,31,41] The use of engineering controls (e.g., safety devices) and changes in work practices (e.g., techniques to reduce handling of sharp instruments) can reduce the frequency of percutaneous injuries.[41,42] In settings such as the operating room, changes in instrument design and techniques for performing surgical procedures and modified personal barriers have been shown to reduce blood contacts.[43,44] Despite adherence to standard precautions and implementation of some new techniques and devices, percutaneous injuries continue to occur. This is of concern because percutaneous injuries represent the greatest risk of transmission of bloodborne pathogens to health care personnel.[45] Only a few studies evaluating a limited number of safety devices have demonstrated a reduction in percutaneous injuries among health care workers.[46,47] This document will not address the use of safety devices, because the Public Health Service is assessing the need for further guidance on selection, implementation, and evaluation of such devices in health care settings.

The risk posed to patients by health care personnel infected with bloodborne pathogens such as HBV and HIV has been the subject of much concern and debate. There are no data to indicate that infected workers who do not perform invasive procedures pose a risk to patients. Consequently, work restrictions for these workers are not appropriate. However, the extent to which infected workers who perform certain types of invasive procedures pose a risk to patients and the restrictions that should be imposed on these workers have been much more controversial. In 1991, CDC recommendations on this issue were published.[48] Subsequently, Congress mandated that each state implement the CDC guidelines or equivalent as a condition for continued federal public health funding to that state. Although all states have complied with this mandate, there is a fair degree of state-to-state variation regarding specific provisions. Local or state public health officials should be contacted to determine the regulations or recommendations applicable in a given area. CDC is currently in the process of reviewing relevant data regarding health care personnel–to–patient transmission of bloodborne pathogens.

b. Hepatitis B

Nosocomial transmission of HBV is a serious risk for health care personnel.[49-53] Approximately 1000 health care personnel were estimated to have become infected with HBV in 1994. This 90% decline since 1985 is attributable to the use of vaccine and adherence to other preventive measures (e.g., standard precautions).[54] During the past decade, an estimated 100 to 200 health care personnel annually have died of occupationally acquired HBV infection.[54] The risk of acquiring

Table 4. Recommendation for postexposure prophylaxis for percutaneous or permucosal exposure to hepatitis B virus, United States

Vaccination and antibody status of exposed person	HBsAg seropositive	Treatment when source is HBsAg negative	Treatment when source is not tested or status is unknown
Unvaccinated	HBIG* × 1 and initiate HB vaccine series	Initiate HB vaccine series	Initiate HB
Previously vaccinated			
Known responder†	No treatment	No treatment	
Known nonresponder	HBIG* × 2 or HBIG* × 1 and initiate revaccination	No treatment	If known high-risk source, treat as if source were HBsAg positive
Antibody response unknown	Test exposed person for anti-HBs: (1) if adequate,† no treatment; (2) if inadequate,† HBIG × 1 and vaccine booster	No treatment	Test exposed person for anti-HBs: (1) if adequate,† no treatment; (2) if inadequate,† initiate revaccination

HBsAg, Hepatitis B surface antigen; *HBIG*, hepatitis B immune globulin; *HB*, hepatitis vaccine; *anti-HBs*, antibody to hepatitis B surface antigen.
*Dose 0.06 mg/kg IM.
†Responder is defined as a person with adequate serum levels of anti-HBs (≥10 mIU/ml); inadequate vaccination defined as serum anti-HBs <10 mIU/ml.

HBV infection from occupational exposure is dependent on the nature and frequency of exposure to blood or to body fluids containing blood.[49,53] The risk of infection is at least 30% after a percutaneous exposure to blood from a hepatitis B e antigen–seropositive source.[54]

HBV is transmitted by percutaneous or mucosal exposure to blood and serum-derived body fluids from persons who have either acute or chronic HBV infection. The incubation period is 45 to 180 days (average 60 to 90 days). Any person seropositive for hepatitis B surface antigen (HBsAg) is potentially infectious.

Hepatitis B vaccination of health care personnel who have contact with blood and body fluids can prevent transmission of HBV and is strongly recommended.[9,10,40] The OSHA bloodborne pathogen standard mandates that hepatitis B vaccine be made available, at the employer's expense, to all health care personnel with occupational exposure to blood or other potentially infectious materials.[27] Provision of vaccine during training of health care professionals before such blood exposure occurs may both increase the vaccination rates among personnel and prevent infection among trainees, who are at increased risk for unintentional injuries while they are learning techniques.

Prevaccination serologic screening for susceptibility to HBV infection is not indicated for persons being vaccinated, unless the health care organization considers such screening to be cost-effective. Postvaccination screening for antibody to HBsAg (anti-HBs) is advised for personnel at ongoing risk for blood exposure to determine whether response to vaccinations has occurred and to aid in determining the appropriate postexposure prophylaxis or the need for revaccination. Personnel who do not respond to or do not complete the primary vaccination series should be revaccinated with a second three-dose vaccine series or evaluated to determine whether they are HBsAg seropositive. Revaccinated persons should be tested for anti-HBs at the completion of the second vaccine series.[9] If they do not respond, no further vaccination series should be given and they should be evaluated for the presence of HBsAg (possible chronic HBV infection). No specific work restrictions are recommended for nonresponders; in the event of percutaneous exposure to blood or body fluids, however, they should see their health care providers as soon as possible to evaluate the need for postexposure prophylaxis. Personnel in chronic dialysis centers who do not respond to vaccine need to be screened for HBsAg and anti-HBs every 6 months.[55]

Vaccine-induced antibodies decline gradually with time, and as many as 60% of those who initially respond to vaccination will lose detectable anti-HBs by 8 years.[56] Booster doses of vaccine are not routinely recommended, because persons who respond to the initial vaccine series remain protected against clinical hepatitis and chronic infection even when their anti-HBs levels become low or undetectable.[57]

The need for postexposure prophylaxis, vaccination, or both depends on the HBsAg status of the source of the exposure as well as the immunization status of the person exposed (Table 4).[40]

Vaccine should be offered after any exposure in an unvaccinated person; if the source is known to be HBsAg seropositive, hepatitis B immune globulin (HBIG) should be given, preferably within 24 hours. The effectiveness of HBIG given later than 7 days after HBV exposure is unknown.[8,10,40] If the source is HBsAg seropositive and the exposed person is known not to have responded to a three-dose vaccine series, a single dose of HBIG and a dose of hepatitis B vaccine need to be given as soon as possible after the exposure with subsequent vaccine doses given at 1 month and 6 months after the initial dose. If the exposed person is known not to have responded to a three-dose vaccine series and to revaccination, two doses of HBIG need to be given, one dose as soon as possible after exposure and the second dose 1 month later.

c. Hepatitis C

HCV is the etiologic agent in most cases of parenterally transmitted non-A, non-B hepatitis in the United States.[58,59] During the past decade, the annual number of newly acquired HCV infections has ranged from an estimated 180,000 in 1984 to an estimated 28,000 in 1995. Of these, an estimated 2% to 4% occurred among health care personnel who were occupationally exposed to blood.[59]

A case-control study of patients with acute non-A, non-B hepatitis, conducted before the identification of HCV, showed a significant association between acquisition of disease and health care employment, specifically patient care or laboratory work.[60] Seroprevalence studies among hospital-based health care personnel have shown seroprevalence rates of antibody to HCV (anti-HCV) ranging from 1% to 2%.[61-64] In a study that assessed risk factors for infection in health care personnel, a history of accidental needlesticks was independently associated with anti-HCV seropositivity.[61]

Several case reports have documented transmission of HCV infection from anti-HCV–seropositive patients to health care personnel as a result of accidental needlesticks or cuts with sharp instruments.[65,66] In follow-up studies of health care personnel who sustained percutaneous exposures to blood from anti-HCV–seropositive patients, the rate of anti-HCV seroconversion averaged 1.8% (range 0% to 7%).[67-70] In a study in which HCV RNA polymerase chain reaction methods were used to measure HCV infection, the rate of HCV transmission was 10%.[70]

The incubation period for hepatitis C is 6 to 7 weeks, and nearly all persons with acute infection will have chronic HCV infection occur with persistent viremia and the potential for transmission of HCV to others.

Serologic assays to detect anti-HCV are commercially available. The interpretation of anti-HCV test results is limited by several factors: (a) these assays will not detect anti-HCV in approximately 5% of persons infected with HCV; (b) these assays do not distinguish between acute, chronic, and past infection; (c) there may be a prolonged interval between the onset of acute illness with HCV and seroconversion; and (d) when the assays are used in populations with a low prevalence of HCV infection, commercial screening assays for anti-HCV yield a high proportion (as great as 50%) of false-positive results.[34,59] Although no true confirmatory test has been developed, supplemental tests for specificity are available and should be used to judge the validity of repeatedly reactive results by screening assays.

Although the value of immune globulin for postexposure prophylaxis after occupational exposure to HCV has been difficult to assess,[71-73] postexposure prophylaxis with immune globulin does not appear to be effective in preventing HCV infection. Current immune globulin preparations are manufactured from plasma that has been screened for HCV antibody; positive lots are excluded from use. An experimental study in chimpanzees found that administration 1 hour after exposure to HCV of immune globulin manufactured from anti-HCV–screened plasma did not prevent infection or disease.[74] Thus, available data do not support the use of immune globulin for postexposure prophylaxis against hepatitis C, and its use is not recommended. There is no information regarding the use of antiviral agents, such as interferon alfa, in the postexposure setting, and such prophylaxis is not recommended.[37]

Health care institutions should consider implementing recommended policies and procedures for follow-up for HCV infection after percutaneous or mucosal exposures to blood. At a minimum, such policies can include (1) baseline testing of the source for anti-HCV, (2) baseline and follow-up testing (e.g., 6 months) for anti-HCV and alanine aminotransferase activity of the person exposed to an anti-HCV seropositive source, (3) confirmation by supplemental anti-HCV testing of all anti-HCV results reported as repeatedly active by enzyme immunoassay, (4) recommendation against postexposure prophylaxis with immune globulin or antiviral agents (e.g., interferon), and (5) education of health care personnel

about the risk for and prevention of bloodborne infections, including HCV, in occupational settings, with the information routinely updated to ensure accuracy.[37] Among health care personnel in the postexposure period, onset of HCV infection may be detected earlier by measuring HCV RNA with polymerase chain reaction rather than by measuring anti-HCV with enzyme immunoassay. However, polymerase chain reaction is not a licensed assay, and the accuracy of the results are highly variable.[37]

d. Human immunodeficiency virus

Nosocomial transmission of human immunodeficiency virus (HIV) infection from patients to health care personnel may occur after percutaneous or, infrequently, mucocutaneous exposure to blood or body fluids containing blood. According to prospective studies of health care personnel percutaneously exposed to HIV-infected blood, the average risk for HIV infection has been estimated to be 0.3%.[45,75-78] A retrospective case-control study to identify risk factors for HIV seroconversion among health care personnel after a percutaneous exposure to HIV-infected blood found that they were more likely to become infected if they were exposed to a larger quantity of blood, represented in the study as (1) presence of visible blood on the device before injury, (2) a procedure that involved a needle placed directly in the patient's vein or artery, or (3) deep injury.[45] Transmission of HIV infection also was associated with injuries in which the source patient was terminally ill with AIDS; this may be attributable to the increased titer of HIV in blood that is known to accompany late stages of illness or possibly to other factors, such as the presence of syncytia-inducing strains of HIV in these patients. In addition, the findings of this study suggested that the postexposure use of zidovudine may be protective for health care personnel.[45]

Factors that determine health care personnel's risk of infection with HIV include the prevalence of infection among patients, the risk of infection transmission after an exposure, and the frequency and nature of exposures.[79] Most personnel who acquire infection after percutaneous exposure have HIV antibody develop within 6 months of exposure. HIV-infected persons are likely to transmit virus from the time of early infection throughout life.

In 1990, CDC published guidelines for postexposure management of occupational exposure to HIV,[33] and provisional recommendations for postexposure chemoprophylaxis were published in 1996.[80] In 1998, both of these documents were updated and consolidated to reflect current scientific knowledge on the efficacy of postexposure prophylaxis and the use of antiretroviral therapies.[81] The U.S. Public Health Service will periodically review scientific information on antiretroviral therapies and publish updated recommendations for their use as postexposure prophylaxis as necessary.

2. Conjunctivitis

Although conjunctivitis can be caused by a variety of bacteria and viruses, adenovirus has been the primary cause of nosocomial outbreaks of conjunctivitis. Nosocomial outbreaks of conjunctivitis caused by other pathogens are rare.

Adenoviruses, which can cause respiratory, ocular, genitourinary, and gastrointestinal infections, are a major cause of epidemic keratoconjunctivitis in the community and health care settings. Nosocomial outbreaks have primarily occurred in eye clinics or offices but have also been reported in neonatal intensive care units and long-term care facilities.[82-86] Patients and health care personnel have acquired and transmitted epidemic keratoconjunctivitis during these outbreaks. The incubation period ranges from 5 to 12 days, and shedding of virus occurs from late in the incubation period to as long as 14 days after onset of disease.[83] Adenovirus survives for long periods on environmental surfaces; ophthalmologic instruments and equipment can become contaminated and transmit infection. Contaminated hands are also a major source of person-to-person transmission of adenovirus, both from patients to health care personnel and from health care personnel to patients. Handwashing, glove use, and disinfection of instruments can prevent the transmission of adenovirus.[82,83]

Infected personnel should not provide patient care for the duration of symptoms after onset of epidemic keratoconjunctivitis[82,83] or purulent conjunctivitis caused by other pathogens.

3. Cytomegalovirus

There are two principal reservoirs of cytomegalovirus (CMV) in health care institutions: (a) infants and young children infected with CMV and (b) immunocompromised patients, such as those undergoing solid-organ or bone-marrow transplantation or those with AIDS.[87-94] However, personnel who provide care to such high-risk patients have a rate of primary CMV infection that